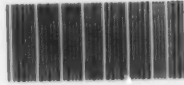


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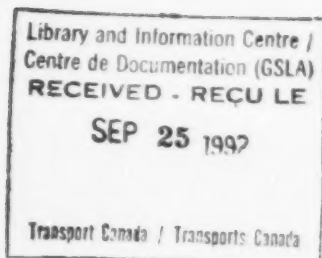
TP 11307E

**COMMUNICAID II: Development of a prototype
information system for sensory and speech
impaired persons in transportation terminals**

developed by:
Transportation Development Centre
Policy and Coordination
Transport Canada

developed by:
Rutenberg Design Inc.

March 1992



The contents of this report reflect the views of the contractor and not necessarily the official views of the Transportation Development Centre of Transport Canada.

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16. Abstract This report describes the development of the COMMUNICAID II prototype designed for use in transportation terminals as an independent information centre by all travellers including those with hearing, speech and sight impairments, people using wheelchairs and elderly persons. This information centre consists of two semi-private sections. Both can be used by the general public, and one section is designed specifically to accommodate the ergonomics requirements of travellers with sensory and physical disabilities. Features on the section for the disabled include: a tilting touch screen colour monitor, adjustable for operation from a sitting or standing position; for the elderly a swing-out seat; ample foot and knee clearance for ease of access by people using a wheelchair; for visually impaired travellers, large letters on the screen and an audio mode for the same information; laser printed hard-copy maps indicating the shortest route to airport facilities. All information is provided in English and French in text and audio mode. The information is terminal-specific and includes flight arrival and departure schedules of all airlines, an airport directory, and details regarding accessible ground transportation, hotels and local associations for disabled persons. A prototype was installed in May 1990 at Vancouver International Airport, where it was demonstrated for several months. After successfully achieving the objectives for demonstrating and evaluating user-interface technology, as well as operational aspects and technical limitations, the prototype was dismantled for future development work in Montreal.					
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16. Résumé Ce rapport décrit les travaux de mise au point du prototype de COMMUNICAID II, système de communication utilisé dans les aéroports et destiné tant au grand public qu'aux personnes en fauteuil roulant, ayant un handicap auditif, visuel ou d'élocution, ou simplement âgées. Ce système, aménagé dans deux enceintes semi-ouvertes, sert à tous les voyageurs, mais l'une de ces enceintes est aménagée pour répondre aux besoins des voyageurs à mobilité réduite ou ayant un handicap sensoriel. Cette dernière comporte les aménagements suivants : un écran couleur tactile inclinable, réglable à la hauteur d'une personne assise ou debout; un siège pivotant escamotable destiné aux personnes âgées; un dégagement suffisant au niveau des pieds et des genoux pour les personnes en fauteuil roulant; un affichage en gros caractères doublé d'une information audio pour les personnes ayant un handicap visuel. Une imprimante au laser permet d'obtenir sur un support papier l'information cartographique affichée, par exemple, le chemin le plus direct vers une destination particulière dans l'aéroport. Toutes les communications, tant visuelles qu'auditives, sont faites dans les deux langues officielles, français et anglais. Les informations fournies par le système COMMUNICAID II sont adaptées à chaque aéroport. Elles comprennent notamment des renseignements sur les horaires des avions, sur les transports de surface adaptés, sur les hôtels aménagés pour recevoir une clientèle handicapée et sur les associations de personnes handicapées, ainsi qu'un répertoire des aménagements aéroportuaires. Le prototype, installé à l'aéroport international de Vancouver en mai 1990, a servi pendant plusieurs mois. Au cours de cette période d'exploitation expérimentale dans le contexte d'un aéroport, les chercheurs ont pu évaluer le système du point de vue des interactions homme-machine, vérifier les limites de la technologie mise en œuvre et l'éprouver dans des conditions de service. Par la suite, le système a été démantelé et ramené à Montréal pour y être perfectionné et modernisé.					
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SUMMARY

In 1987, Rutenberg Design Inc. was awarded a contract to design and build a COMMUNICAID II prototype equipped with a computerized information system for demonstration at Vancouver International Airport.

As a result of an ergonomic evaluation of the first prototype and the establishment of operational requirements of such a new product for an airport, the objective for phase II was threefold: first, to design an information centre accessible to the disabled target groups and the general public; second, to design the centre to operate without an operator/assistant; and third, to use as much of the present visual and audio data as possible.

During the development process the emphasis was placed on finding the essential information that would allow each disability group to function independently, relying not on human assistance, but on the application of advanced computer technology instead.

The physical configuration of the centre was determined by the need to accommodate two passengers simultaneously, one disabled and one representing the general public. Other factors included the need to scale the centre to air terminal furniture proportions, e.g. airline counters, concessionaires, signage, sightlines from different points of the terminal, central location and visibility from main entrances.

The decision to install and test COMMUNICAID II at Vancouver International Airport was made because the original data for text, graphics and audio were still available and would allow cost savings.

The information centre consists of two semi-private sections opposite each other. Both can be used by the general public, but one is designed specifically to accommodate the requirements of travellers with hearing, speech and sight impairments, travellers using a wheelchair and elderly persons.

Features on the section for the disabled include a tilting color touch screen monitor which can be accessed from a seated or standing position; a swing-out seat for frail or elderly persons; clearance for foot and knee for travellers using a wheelchair; and a handrail at waist-height to facilitate access to and egress from the seat. On the public side the touch screen monitor can be accessed from a standing position.

The information is provided in visual mode on both screens, and on laser printed maps and in audio mode in the section for disabled persons. At the public section all information is provided in visual mode only. Visual and audio information is displayed in both official languages, English and French. Additional languages can be added if required.

The information provided at COMMUNICAID II is terminal-specific, essential for the passenger for orientation, for finding his/her way to specific locations within the terminal, and for obtaining flight-related information. It includes flight arrival and departure schedules in alphabetical order, location of facilities within the terminal for all levels, vertical and horizontal access facilities nearest the information centre, ground transportation, accessible hotels, and a list of associations for disabled persons.

The design of the display was based on the requirements of particular disabled groups: large white letters on a dark background for the visually impaired; accompanied by audio output for those who cannot see even large letters; audio also for those passengers who can understand spoken English or French, but cannot read it.

The computer terminal consists of two PCs 286, an HP Laser Printer, two NEC touch screens and a stereo speaker system.

In May 1990, the prototype was installed at level 3, Vancouver International Airport. In the first couple of months, great enthusiasm was expressed by people who had used the system. However it became evident that the capacity of the PCs 286 was at its utmost limit, especially in generating the graphic-based screen information, and many found the system too slow. Another factor limiting performance was the integration of the Flight Information System (FIDs). Vancouver Airport was in transition at this time and not able to provide a direct link with three different FIDs systems. An arrangement with Rogers Cable provided some of the FID's data for several months but had problems in updating and provided only partial data. This created several problems in the system design of the program and resulted in system failures at unpredictable times. In October 1991 the centre was dismantled and the computer terminals were brought back to Montreal for future development and updating of the technology.

The objective of the development program - to test and demonstrate the prototype in a terminal environment - was successfully achieved. The prototype allowed developers to determine and evaluate the interface actions between the technology and the user, to verify the limits of the applied technology, and to assess the systems performance under real conditions. This development phase indicated that significant improvements can be achieved by implementing recent advanced technologies, such as Interactive Video; by integrating high quality audio, using consolidated FIDs systems; and by improving the interface design elements for disabled persons.

It is recommended that, as the next step toward introducing this product to the market, the system be refined, a preproduction model fabricated, and demonstrations conducted in various Canadian airports.

Sommaire

En 1987, la firme Rutenberg Design Inc. a remporté le marché pour la conception et la réalisation du prototype de COMMUNICAID II, système informatisé de communication, devant être mis en service expérimental à l'aéroport international de Vancouver.

À la lumière de l'évaluation ergonomique du premier prototype et du cahier des charges fonctionnel d'un tel système aéroportuaire, les objectifs fixés à la phase II ont été les suivants : réaliser un centre d'information 1) accessible tant à des groupes cibles de personnes handicapées qu'au grand public, 2) fonctionnant sans préposé aucun et 3) utilisant le maximum possible des informations audiovisuelles existantes.

Les travaux de développement ont consisté surtout à cerner l'information qui permettrait à chacun des groupes cibles de personnes handicapées d'utiliser le système au mieux, non pas grâce à l'assistance d'un préposé, mais par la mise en oeuvre de techniques informatiques avancées.

Le centre d'information a été organisé de manière à pouvoir servir deux utilisateurs en même temps, l'un des deux étant une personne handicapée. Par ses proportions, le centre s'intègre aux équipements qui meublent d'ordinaire une aérogare : comptoirs, magasins, panneaux de signalisation, repères visuels selon la distance d'éloignement, tout en occupant une place centrale et étant visible depuis les portes d'entrée.

Pour le choix du site d'implantation, l'aéroport international de Vancouver, les chercheurs ont tenu compte du fait que les informations audiovisuelles existantes pouvaient resservir, d'où d'intéressantes économies.

Le centre fonctionne à l'intérieur de deux enceintes semi-ouvertes, placées dos à dos; il est à la disposition de tous les voyageurs, mais

l'une des enceintes est conçue en fonction des besoins des voyageurs en fauteuil roulant, ayant un handicap visuel, auditif ou d'élocution, ou simplement âgés.

Dans cette dernière sont aménagés un écran couleur tactile inclinable, réglable à la hauteur d'une personne assise ou debout, un siège pivotant escamotable destiné aux personnes frêles ou âgées, de l'espace au niveau des pieds et des genoux pour manoeuvrer un fauteuil roulant et une main courante à hauteur de la taille pour faciliter les déplacements. L'écran tactile placé dans l'enceinte destinée au grand public est réglable à la hauteur d'une personne debout.

L'information est présentée sur écran dans les deux enceintes, alors que dans celle aménagée pour les personnes handicapées, elle est reprise en phonie et disponible sur imprimé laser. Toutes les communications, tant visuelles qu'auditives, sont faites dans les deux langues officielles, français et anglais, mais, le cas échéant, d'autres langues pourraient être ajoutées.

Les informations fournies par le système COMMUNICAID II sont naturellement adaptées à chaque aéroport : orientation générale, ou vers une destination particulière dans l'aéroport, et renseignements sur les horaires des avions. Ces informations sont les suivantes : arrivées et départs indiqués par ordre alphabétique, emplacement des divers aménagements de l'aéroport, selon l'étage, situation des aménagements de transport horizontal et vertical les plus proches du centre d'information, services de transport de surface, hôtels aménagés pour recevoir une clientèle handicapée et liste des associations pour personnes handicapées.

Les caractéristiques de l'information affichée répondent aux besoins des groupes cibles de personnes handicapées : lettres blanches en gros caractères sur fond noir pour les personnes handicapées visuelles, information auditive d'appoint pour les personnes qui ont la vue très

basse, information auditive également pour les voyageurs qui comprennent le français ou l'anglais parlé mais qui ne le lisent pas.

Le matériel informatique comporte deux PC 286, une imprimante HP au laser, deux écrans tactiles NEC et des haut-parleurs stéréo.

En mai 1990, le prototype a été installé au niveau 3 de l'aéroport international de Vancouver. Au début, ceux qui l'ont utilisé l'ont trouvé très utile. Mais, on s'est rendu compte que les fonctionnalités du système exigeaient toute la capacité de mémoire vive des PC 286, surtout pour afficher l'information infographique, et on a constaté que tout le système était trop lent. L'autre facteur limitatif était la difficulté d'intégration des données du Système d'information sur les vols. L'aéroport de Vancouver, en pleine transition, ne pouvait offrir une liaison directe avec les trois différents systèmes d'information sur les vols alors en service. Une entente avec Rogers Cable a permis d'obtenir les informations nécessaires pendant quelques mois, mais des difficultés dans les mises à jour ont surgi et les données affichées n'ont jamais été mieux que partielles. Le programme d'intégration de ces données a connu des ratés, au point que le système tout entier pouvait tomber en panne de manière imprévisible. En octobre 1991, le centre d'information a été démantelé et le matériel informatique ramené à Montréal pour y être perfectionné et modernisé.

L'objectif du programme de développement a été atteint : mettre le prototype à l'essai en service expérimental dans le contexte d'une aérogare. Les chercheurs ont pu ainsi évaluer le système du point de vue des interactions homme-machine, vérifier les limites de la technologie mise en oeuvre et l'éprouver dans des conditions réelles de service. Ils ont trouvé que d'importantes améliorations pourraient être apportées par la mise en oeuvre de technologies de pointe telles que la vidéo interactive, par l'intégration d'éléments audio de haute qualité, par la consolidation des systèmes d'information sur les vols et par le perfectionnement des fonctions d'interface utilisables par les personnes handicapées.

La prochaine étape vers la mise en marché recommande le perfectionnement du système, la réalisation d'un prototype présérie et de la mise en service expérimental dans divers aéroports canadiens.

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1. INTRODUCTION

This report describes the development of the COMMUNICAID II prototype, an independent information centre for use in transportation terminals to facilitate information access for all passengers including those with hearing, speaking and visual impairments, people using wheelchairs, and elderly persons. Currently many passengers with sensory and physical impairments have great difficulty accessing essential information in a terminal. They must often go to great lengths and suffer embarrassing situations to obtain information. Many elderly persons cannot assimilate information fast enough. For hearing PA announcements, seeing small letters on screens, knowing where facilities are, and how to get there, and communicating for help, many disabled and elderly persons must rely on a companion or carrier assistance.

2. BACKGROUND

As a result of an unsolicited proposal by Rutenberg Design Inc. in 1984, a proof-of-concept model was developed for the Transportation Development Centre of Transport Canada (Rutenberg U., Design, Development, and Testing of an Integrated Communication System for the Sensory and Speech Impaired at Transportatiuon Terminals, TP 8806E, 1987). Its aim was to provide information and communication to impaired travellers by applying new technologies for information retrieval, and a combination of technology and human assistance for communication. A first generation prototype was built and demonstrated at Vancouver International Airport for EXPO 86. An ergonomic evaluation (Ergonomics Evaluation of Communicaid, Dr. Ruth Heron, 1987) of the model indicated an enthusiastic response from the disabled community for the concept. From an operational point of view the need to eliminate human assistance was voiced strongly by airport authorities. These two factors led to the separation for communication on one hand and information on the other. As a result it was felt that a prototype should be developed addressing terminal-specific information only in an independent station.

3. OBJECTIVES

The overall objective of this project was to make transportation terminals accessible for passengers with speaking, hearing and visual impairments, people using wheelchairs and elderly persons. The specific objective was to fulfill the ergonomic information requirements of the disabled groups by combining state-of-the-art technology with a human factors design approach.

4. ERGONOMICS REQUIREMENTS

The potential target group for this project was characterized as follows:

- hearing impaired persons who can read English or French and might be able to speak both languages, but cannot hear regular voice levels;
- speech impaired persons who can hear and read English or French, but cannot speak loudly or clearly enough to carry out a dialogue;
- visually impaired persons who are not completely blind and can find their way without the help of an assistant/companion but cannot read print smaller than 14 points;
- wheelchair users who are only mobility impaired or who are hearing, speech or visually impaired in addition to their mobility impairment;
- elderly persons who might have a general reduction of physical and sensory capabilities in one or more areas.

4.1 Hearing impaired travellers

In this group, the following levels of hearing impairment can be found:

- a) total deafness
- b) perception of some sound levels, but unable to distinguish words
- c) hearing with one ear only
- d) reduced hearing in both ears.

For the totally deaf, the problem is not only the inability to perceive audio signals, but also the lack of audio stimuli that compose daily life situations. Very often, underdeveloped speech is combined with this impairment, due to the lack of feedback and the inability to control it.

Deaf people rely heavily on their vision to perceive information, e.g. sign language, lip reading, written text and symbols. Some hearing impaired persons perceive noise and can make a distinction between loud and low intensity but cannot distinguish words. For people with reduced hearing in one or both ears, an increase in volume intensity can sometimes help, e.g. use of amplifying earpieces, volume controlled phones, etc. When the hearing reduction or loss is in one ear, the result is not only lack of perception on that side but lack of three-dimensional location of the sound source.

For hearing impaired travellers to access information the following elements are required:

- * clear and concise visual information on all audio components contained in a message, e.g. flight schedules, PA announcements, changes, delays, etc.;
- * unobstructed view of the visual display components, e.g. text, symbols, signs;
- * efficient light level to view displays, signs etc.;
- * hard copy of critical information, e.g. schedule changes;
- * use of fast and logical input and response devices;
- * ergonomically designed visual screen displays, e.g. letter style, size, color contrast, punctuation;
- * ergonomically designed screen lay-out for effective and logical information processing, e.g. number of choices, position of receiving and sending messages, wording, linguistic characteristics.

4.2 Speech impaired travellers

Speech impairment is usually related to other impairments. For example individuals in wheelchairs may have speech impairments due to injury to their nervous systems and deaf persons may have speech impairments due to the lack of audio feedback. Stuttering, another impairment, requires a slower pace for dialogue.

Considering the specific information situation in a transportation terminal, the following is required if the individual can hear and understand clearly:

- * a clear visual or audio message containing all message components.

If the individual cannot hear, the following elements are required:

- * unobstructed view of the visual display components, e.g. text, symbols, signs;
- * reflection and glare-free display of visual information;
- * use of fast and logical input and response devices for information retrieval;
- * controlled light levels for text, symbol and sign display;
- * ergonomically designed visual display, e.g. letter size, style, color, punctuation;

- * ergonomically designed screen lay-out for effective and logical information processing, e.g. number of choices, position for receiving and sending messages, wording, linguistic characteristics.

Although speech impaired persons might be able to hear the audio message, the noisy terminal environment could make it necessary for them to rely on visual messages only.

4.3 Visually impaired travellers

Visual impairment ranges from total blindness to the wearing of corrective glasses. A totally blind passenger is very unlikely to venture into an unknown transportation terminal without the help of other people. It is therefore assumed that a totally blind traveller will make arrangements with the carrier or have an assistant to access the information necessary to travel.

The individual who could profit from an information centre could have some of the following characteristics:

- * can detect dark or light and uses a seeing-eye dog or canes;
- * has reduced peripheral vision;
- * has reduction of perception of the right and left sides;
- * has tunnel vision, a reduction in lateral and horizontal sight lines, where only the centre appears sharp and the surroundings are blurred;
- * uses strong corrective lenses, which reduce lateral sharpness and can distort vision at certain angles;
- * is color blind and cannot distinguish between green and red tones;
- * has lost one eye or is blind on one eye, therefore three-dimensional perception is virtually lost;

Only 10% of the visually impaired population can read braille.

The following elements are required to enable the visually impaired to access information in audio mode:

- * clear concise audio messages, not more than 5-7 items per unit for selection and memory;
- * stereo sound or sound from both sides;
- * use of familiar input and response devices, e.g. telephone receiver, number pad, tactile buttons/switches;
- * audio messages in clock mode for location of facilities e.g. "proceed in 3 o'clock direction".

For accessing information in visual mode:

- * anti glare display screen with high letter to background contrast; background to be dark, letters to be light;
- * letter size to be at least 14 points medium, letter style without serifs;
- * efficient ambient light level for detection of controls, hardware elements, handrails etc.;
- * hard-copy print-outs of maps with shortest routes.

Other requirements

- * hard surfaces to stand and walk on for audio feedback;
- * place for seeing-eye dog;
- * tactile surfaces for different control buttons;
- * no protruding elements from waist up.

4.4 Wheelchair users and motor impaired travellers

People with motor impairments are generally confined to wheelchairs. The cause of their impairment can be any of the following:

- a) paralysis,
 - paraplegic - lower limb partially or totally affected;
 - quadraplegic - all four limbs affected;
 - hemiplegic - one side of the body affected with partial or local paralysis;
- b) spinal injuries and other back ailments;
- c) deformities of the spine, hip, or pelvis;
- d) amputations or artificial limbs;
- e) loss of joint mobility due to rheumatoid arthritis and other musculoskeletal diseases;
- f) loss of controlled movement, such as occurs in spastics, with multiple sclerosis and other types of motor coordination disorders;
- g) motor disorders - ability to move limbs but not to control them.

The most significant problems for wheelchair users in terminals are the finding, location and use of level changes, long distances to gates and facilities, viewing distance to monitors, and access to standard information devices, such as phones, counters and other display elements.

Sensory impairments are often combined with the use of a wheelchair - for example, slurred speech and motor deficiencies. This makes standard input controls such as key-pads difficult or impossible to use.

The following elements were considered necessary for convenient information retrieval:

- * table and workplace heights at 78 cm(31"), clearing armrests of wheelchair;
- * display screens at about 101 cm (40") high;
- * display screen angle adjustable between 45 and 60 degrees,
- * knee and foot rest clearance;
- * rest area for arms or hands, when using touch screen;
- * lateral reach area of 50 cm (20");
- * hard, non-slip surfaces for manoeuvring of wheelchair.

Input and response controls should have the following:

- * large area push button controls with audio feedback, e.g. "click" or "beep";
- * ample distance between control buttons or touch areas;
- * no fine finger controls such as turning, twisting, sliding, pivoting.

4.5 Elderly travellers

4.5.1 Physical

For elderly persons, the following physical or sensory deficiencies may occur as a result of the natural aging process:

- a) decreased standing height as a result of greater slouch and compression of the fibrous discs between the vertebrae;
- b) loss of mobility and agility due to structural changes in the joints and reduced muscle flexibility;
- c) decreased muscular strength; at age sixty, a person might have only 60% of the strength he/she had at thirty;
- d) lengthened reaction time; at sixty it is about twice as long as at age thirty;
- e) diminished sensitivity to vibration, possibly.

4.5.2 Vision

At age sixty, the minimum focal distance (uncorrected) may be as great as 101.6 cm (40"). Also, acuity decreases for distant vision. Even with corrective lenses, normal vision may not be achieved.

Eye diseases such as cataracts and retinal degeneration increase, affecting depth perception.

Ability to see in dim lighting is reduced.

Colour perception changes; the world may look bluer to the elderly.

4.5.3 Hearing

Hearing loss becomes more acute with age. A child can hear a frequency of 20 000 Hz. At age thirty, a person can hear up to 15 000 Hz., and at age fifty, the limit is 13 000 Hz.

A loss of 45 decibels in hearing acuity makes it difficult for a person to make out direct conversation; a loss of 65 decibels makes it difficult to hear over the telephone.

For the elderly, the following elements were considered important to facilitate their access for information:

Physical

- * components within close reach from standing and sitting position;
- * simple hand-finger and arm movements for controls, no strong gripping, wrist movements, precise finger pointing, lifting, pulling or pushing;
- * visual and audio information equipment with adjustable speed and intensity to allow sufficient reaction time and the possibility for repetition;
- * no tactile-sensitive controls.
- * no long walking distances, stairs or standing.

Hearing

- * no frequencies over 13 000 Hz or under 60 Hz;
- * stereophonic sound;
- * ambient noise blocked out whenever possible;
- * clear sound source;
- * volume control;
- * visual back-up of audio information.

5. OPERATIONAL REQUIREMENTS

Transportation terminals are public places where either the owner or tenants are responsible for providing information to the public. In both cases the tendency is to rely on technology and avoid personnel cost. An information centre therefore must be an independent station which does not require an attendant for its operation. For maintenance, service and updating of data a service contract seems to be the preferable solution. Since public places such as airports and train and bus terminals can only provide limited security measures, vandalism of unattended facilities can create a problem. Components must therefore be secured and the materials and design used should reduce, if not prevent, the possibility of vandalism. Because floor cleaning equipment, such as washing, waxing and vacuum machines, is used frequently an information station must be protected against the resultant wear and tear. The following are important aspects for the design of an unattended station from an operational point of view:

- * use of fasteners and hardware that cannot be tampered with easily;
- * use of materials and finishes to protect against the wear and tear of cleaning equipment, and against vandalism;
- * securing of computer equipment by locked doors or panels;
- * easy access to components for service personnel;
- * materials used for station to conform to fire safety regulations of terminals.

6. TECHNICAL REQUIREMENTS

The technical requirements can be divided into two sections, one for the enclosure station design, and the other for the performance of the computer terminal and its related components.

Enclosure

The enclosure must be of a durable shell resistant to the daily wear and tear of passenger use. Such an enclosure and its parts would be produced in small quantities, allowing customization for different terminal requirements, e.g. one or multiple station use, network arrangements, additional information displays for tourism. This information station must firmly stand on its own, resistant to people leaning against it. Permanently lit signs and symbols are necessary, and must be visible from near and far within the terminal.

Computer terminal

The computer terminal must fulfill the following functions:

- * capability of data storage for visual and audio data in English and French;
- * retrieval of and response to text and graphic data via two touch screen color monitors simultaneously;
- * integration of terminal flight schedule data into system;
- * stereophonic audio output for one section;
- * laser printer output for one section;
- * data update through keyboard;
- * local telephone line with restriction for long distance;
- * electrical connection: 15 A conditioned power supply, 110 V;
- * dust insulation and heat dissipation for laser printer.

7. DESIGN REQUIREMENTS

With the application of high technologies at workplaces and at home, most people of this target group are familiar with the personal computer, keyboard, touchscreen, fax, lightpen, automatic banking machines, etc. There remains of course a segment of the older generation that is still uneasy with this technology. On the other hand, a great number of disabled people have found great help through the application of new technologies, e.g. laser canes, braille computers, sonic devices, robots.

Needless to say, it all depends on how the technology is presented to the user and how he/she can interface with this technology.

Another factor is the terminal environment, which is usually hectic, crowded and noisy, and when combined with jet lag and unfamiliar surroundings can influence the physical and mental alertness of any passenger. The result is often a reduction in physical stamina and in the capacity for processing information, memorizing and concentrating.

The objective for the design of an information station must address many levels: one, the identification of the unit from long or short distances in the airport by color, shape, light, symbol, etc.; two, the direct interaction of all components with the user, e.g. touch screen, phone, hand rail, seat, print-outs, audio displays; three, the choice of materials, finishes and colors; and four, the product semantic, e.g. product appearance to be associated with a "technical", "facility", or "display" product.

8. PROTOTYPE

8.1 System design

The intention of the design is to develop a software system to perform the intended information retrieval for the passenger. The requirements called for two separate stations - one for disabled persons and one for the general public - to be accessed simultaneously.

a) Proximity sensors at each section to activate the program: in audio and visual mode at the section for disabled persons, and in visual mode only at the section for the general public; in both languages, English and French;

b) High resolution color monitors at each section with touch screen for input and response control;

c) Stereophonic voice output at the section for disabled persons, simultaneously with text/graphics display;

d) Integration of airlines flight arrival and departure system into Communicaid II program, to be displayed on same touch screen monitor;

e) Laser printer for the section for disabled persons to print hard copies of airport maps, instruction on how to follow routes, and essential phone numbers of associations;

f) Independent telephone receiver for local calls at section for disabled persons;

g) System to be operating 24 hours without attendance;

h) Data updating through keyboard entry on site;

The development had to take into account the fact that certain hardware and software components from the previous prototype had to be used, such as:

Software: audio files of synthesized speech data regarding terminal specific information from Vancouver Airport;
text and graphic files of data from Vancouver Airport.

Hardware: IBM PC 286 (model 1985) and HP laser printer, (model 1985).

As a result, the system designed uses an IBM PC 286 and an AST PC 286 to drive the visual, audio and FIDs integrated programs. The communication channels consist of two serial ports. The operating system is MS DOS version 3.1. The two computers are linked in a network set up as a base for future networking links of stations in the airport. All software is written in "C".

Graphics

The current system uses a graphics library called Meta-Windows. It supports a medium level of VGA. 16 colors are available at a resolution of 640 x 480. Graphics are imported and used in the PCX (P.C. Paint) format with a limited speed.

Text

The text is handled through a graphics library with a number of available fonts. This will slow down the display rate of the system, but the existing hardware will not support another method.

Speech

The synthesized speech component was developed by the former Centre for Speech Technology Research group in Victoria. Although looking very promising at the start of the project the results for speech quality fell short at the end compared with digitized voice systems. Ideally synthesized speech would present greater flexibility and quality to compose new words and sentences, where each word would be "built" by a number of determined linguistic rules and parameters.

Touch screens

The touch screens used are NEC multisync monitors with an invisible infrared grid. Active areas for touch are large enough to permit people with hand/finger dexterity problems to control them. A touched area initiates a command for the visual as well as the audio part to be displayed. The text and graphics display consist of icons (symbols of the international signs in airports) as well as written text. The active touch area is at the end of each line in a designated location.

Printer

The current laser printer is an older model (1985), still producing a high quality print, but with two drawbacks: one, the limited speed, (printer does not have enough internal memory to print adequate graphics with sufficient speed); two, a small quantity paper tray. Restricted funds did not allow for the purchase of a faster printer with a larger paper storage. Integration of the airport flight information system and printing pages accordingly was considered. At the time of testing this information system was not available. The printer prints from pre-written binary files on the disk, which may limit its flexibility.

Airline information system

The Airline information system , which was available at the time of testing and demonstration of Communicaid II, consisted of three different systems, one owned by Air Canada, fed from Dorval, one by Canadian Airlines International, fed from Calgary, and the third by Delta, fed from Atlanta. Because there are another 25 airlines operating at Vancouver, each joins a different system. Their data are added manually at Vancouver to each system. All systems are used to maximum capacity and did not allow any more hook-up in the airport. As a temporary alternative a reduced dataline from Rogers Cablevision in Vancouver was integrated into the Communicaid II system to demonstrate the potential of such system.

Telephone

The telephone was an independent installation, not integrated into the Communicaid system. Calls were limited to local communication to assist the disabled groups to call their associations, taxis, etc. Although originally part of the design, a receiver with a volume control could not be installed, since these are only available for public pay phones.

Sensors

At each section of the prototype a proximity sensor was installed in the ceiling, to trigger the start of the visual and audio mode, and to greet the user in both languages with an introduction to the information station.

Command file structure

Each line of a command file starts with a command followed by a TAB character, then the contents of the command. The exception to this is the COMMENT command which is a single character that causes all text following it on the line to be ignored. No command (including COMMENT) may have a line length of more than 80 characters. Each line starts a new command so each command must fit only one line except for the SPEAK/PARLEZ commands which may carry over more than one line. If one of these commands should require more than one line, the first character of each line after the first must start with a TAB character so that it may be identified as a continuation of the preceding line. All lines belonging to a single SPEAK/PARLEZ command must immediately follow each other in the command file (it is not permissible to place blank lines or comment lines between any of the lines).

More than one SPEAK/PARLEZ command may be placed in the command file if it is desired to break up the text to make it more readable. Since speaking and processing can be carried out in parallel, breaking up the utterance into several small sentences will result in less delay before the output starts (The second sentence can be processed while the first is being spoken). Only one of SPEAK or PARLEZ may exist in a given command file (it is not permissible to mix languages during output).

Exactly one NOTOUCH command must exist in each command file and no more than one WAIT may exist in any file. If no WAIT command is given, the previous timeout value will be reused (or default timeout values if no previous value has been specified).

Up to 16 TOUCH zones may be specified in each command file. Made up of zones defined by TOUCH commands and the option commands AUD, PRT, MENU, MASIN, and LEVEL.

Any IMAGE commands for a given file must be issued before any commands that generate touch zones. Except as pointed out above, commands may be placed in the command file in any order desired.

Modules

The Communicaid II program is made up of 30 modules. Additional modules and functions are taken from either the standard compiler libraries or the communications or graphics libraries.

Procedure dependencies

The Communicaid II program contains all routines not local to the defining module. Each routine has a number of users. Routines that are local to a module are not included, as changes made to any of these routines will only affect routines in the module in which they are defined. Changes to these routines may require changes to calling routines, so all calling routines should be checked if a called routine is modified in any way that could have a visible effect on its operation. For each module, all functions indicate which routines (in any module) are used by that function.

File descriptions

Command files controlling the menu system indicate the subject of each. English files are listed with an "E", French files with an "F". Command files having a "P" as the 2nd character are printer control files containing commands for generating hardcopy of the information presented in the file having the same name (with P replaced by V). Files not starting with either E or F are not language specific.

Overlay image files

Image files are the visual components of each menu screen. These files are divided into several types. In all cases, the English and French versions are the same, identified with either an "E" or an "F".

Screen images

Image files having EV or FV as the first two characters followed by a menu reference number are screen images. These images are used by the command file having the same menu number (e.g. evl41a1.pcx is used by command file evl41a1) and contain an image appropriate to the information presented. (NOTE: The same image is used by more than one command file in cases where the same information is presented at different locations in the menu structure. In these instances, the file is named for the principal menu providing the information.)

Descriptive overlays

These files represent images containing descriptive text. As with screen images, more than one command file may use the same overlay file.

Title overlays

Image files having ET as the first two characters are titles. These images are used at the top of the screen presented by the command file having the same menu number (e.g. etl41a1.pcx is used by command file evl41a10 and contains text appropriate to the screen presented).

Option overlays

These images are placed on the screen in areas to be active as touch zones where the default touch zone symbol (a blue square) is not appropriate.

8.2 Station design

To address the requirements established in 4, 5 and 6, a design of the station was developed to address the access of terminal specific information by the general public and the disabled groups. Because the requirements for disabled passengers vary from those for the general public in terms of pacedesign of visual and audio display modes, controls for input and retrieval, and interfacing visual and audio information, a two-section station was developed.

One section addresses the requirements of the general public in a semi-private lay-out with one touch screen monitor to be operated from a standing position. The information is displayed in visual mode only, in English and French. The other section, located opposite but within the same station, also has a semi-private layout, but with the following features:

- adjustable touch screen monitor to be operated from a standing or sitting position;
- high resolution color touch screen with large letter text display, graphics for facilities and shortest route indication to facilities;
- local telephone with volume amplifier to call taxis and to communicate with local associations for disabled persons;
- large letter prints for visually impaired persons, printed maps of airport and facility lay-outs indicating shortest routes;
- stereo speaker system for audio mode display, which, if selected, displays sound simultaneously with visual display;
- swing-out seat for elderly persons and wheelchair users who can transfer to seat, to access touch screen at their own pace from seated position;
- handrail at waist height to facilitate getting in and out of seat, and to be used as elbow support when using touch screen from seated position;

- knee, foot and armrest clearance for wheelchair users to access station with wheelchair;
- lit symbols, indicating international symbols for wheelchairs, and visual and hearing impairments at interior of section above head height;
- high color contrast indications for position of information retrieval and accessories, e.g. blue against white for monitor frame, telephone, handrail, printer slot;
- interior section of light, off-white color to provide perception of fresh, clean environment;
- external contours of section in bright green color for visibility from long distances and for shape recognition for visually impaired persons;
- placement of international airport symbols on sides of station to identify nature of information, e.g., symbols for departure, arrival, gates, bus, taxi;
- placement of lit "Info" sign on top of station to be seen from all sides in terminal.



Fig. 1 Communicaid II
section for disabled
persons



Fig. 2 Communicaid II
section for general
public

8.3 Fabrication

The station enclosure was fabricated and assembled at the shops of Rutenberg Design Inc. A number of components, such as vacuum formed parts, bent tubes and machining, were subcontracted to local manufacturers. The core of the station consists of a steel rack with several shelves for storing all computer components, e.g. cpu's, laser printer, amplifier, modems, and all wiring. The shelf housing the laser printer moves on glides to facilitate access to the printer. Two sides of the core are closed with lockable wooden panels, which can be removed completely for service and maintenance. On opposite sides of the core is a section connected containing a monitor, surrounded by semiprivate panels made of sandwiched vacuum formed ABS and a circular overhang ceiling to prevent overhead light from reaching the screen. Above the monitor on the side for disabled persons is a lockable panel which hinges to the outside for loading the papertray of the laser printer. Except for the vacuum formed curved panels, all other panel sections are made of particle board or plywood and finished with a two component scratch-resistant paint or vinyl mat. All metal tubes are finished with a scratch-resistant enamel and baked. For ventilation and heat dissipation two muffin fans are located at the core ceiling to extract air, and one fan to extract directly from the section where the laser printer is situated. All air intakes are covered with foam filters to prevent entrance of excessive dust. Parts were either bought off the shelf or made from readily available materials.



Fig. 3 Core rack section

8.4 Display design

The Communicaid II information centre is designed as a unit that could be used in any type of transportation terminal which has demands for passenger information, especially for those with hearing, speech and visual impairments, wheelchair users and elderly persons. Vancouver International Airport was selected because a substantial amount of audio, text and graphic files was already available from the previous proof-of-concept model. The operating languages are English and French, with the possibility of adding additional languages. Special emphasis was placed on the ergonomic design of the passenger screen display and controls.

Each screen displays, when not in use, three alternating pages, one with the name "Info Centre", one with a graphic showing a finger touching a zone, and a third with a map of the airport.

When a passenger enters a section, the proximity sensor triggers the program to start, showing a page for the selection of a language on the screen and displaying a short introductory voice message in English and French.

After the passenger has selected his/her language, a main menu appears on the screen in large non-serif letters, showing airport symbols and the choice for audio. Choice for audio, language and print are displayed in large colored bars at the bottom of the page. A maximum of seven menu selections are displayed vertically along the page side. The passenger can work his/her way through the menu tree and find maps with the location of nearest facilities, all facilities for all levels of the airport, and accessible hotels, as well as taxi telephone numbers and departure times, bus routes, train connections, etc.

MAIN MENU	
 AIRPORT INFORMATION	☐
 GROUND TRANSPORT	☐
 ASSOC for DISABLED	☐
HOTELS	☐
AUDIO	EN FRANCAIS

Fig.4 Main Menu

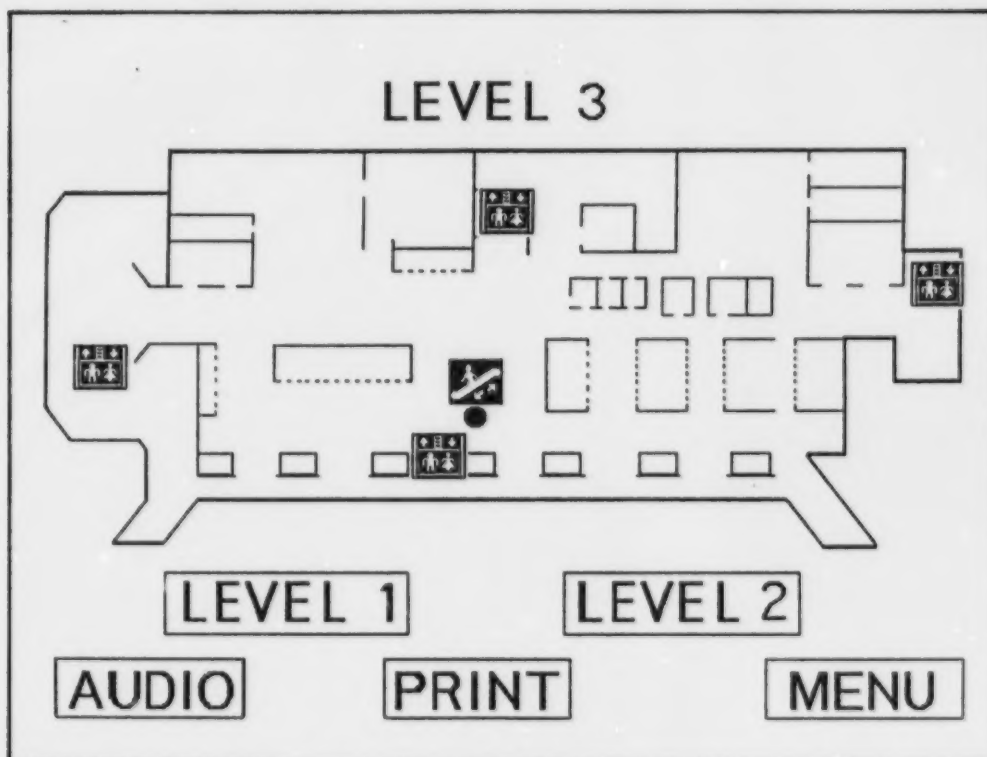


Fig. 5 Airport map print-out

8.5 Operation

Upon arriving at the Communicaid II station, the passengers will find three alternating pages being displayed on the screen, the first indicating that this is an information centre, the second showing a finger touching a zone, thus making the passenger aware of the touch screen control, and the third showing an example of a map.

Once the passenger approaches a screen, a proximity sensor triggers the start of an audio and visual introduction, explaining in a few sentences what kind of information can be obtained. The passenger then chooses the language and all following information will be displayed in visual and audio mode in this language. If the passenger is an elderly person, he/she can pull up a seat which is attached to the centre post and can be swung into a position in front of the screen. To facilitate accessing the seat, a handrail at waist height in front of the monitor allows the passenger to hold onto and steady him/herself. The monitor screen can then be adjusted to an appropriate viewing angle and to avoid reflections.

Although glare and reflections can never be completely eliminated in an airport due to the great variety of light sources and directions, three components were designed for the station to eliminate as much as possible: one, an overhanging ceiling; two, two sidewings; and three, an

adjustable screen. Because the person is sitting or standing relatively close to the screen, some of the reflections from directly behind the person are eliminated.

If the traveller is a person using a wheelchair, a space for clearing the footrest, the knees and the wheelchair's armrests is provided. The swing seat is designed in such a way that a person in a wheelchair can push it aside to make room in front of the monitor, if this person is physically capable of doing so. If a person is using an electric wheelchair, he/she could push the seat out of the way with the wheelchair. If a scooter is used, the scooter must be maneuvered into a sideways position and then turned so that the scooter's seat is facing the front of the monitor.

A visually impaired passenger unable to read the large letters on the screen, but able to detect shapes and dark and light would enter the station and receive an audio message telling him/her to touch a corner of the monitor screen to continue. All information would then be displayed in audio with locations and directions being given in the clock mode, e.g. "Proceed in 3 o'clock direction for 10 paces, turn left in 12 o'clock direction and walk 5 paces. The counter is to your left". A visually impaired person able to read the large letters close up could use only the visual mode or both visual and audio at the same time. This person can also choose a hard print copy of a map showing the shortest distance to a facility. Each page has a "Previous menu" control in case the passenger makes a mistake and wants to choose something else. The contours of the monitor, the handrail and the phone receiver have been color-coded in a high contrast of intense blue and white to assist visually impaired persons to identify their locations. To provide consistency in information throughout the airport, whenever possible, a word on the screen is accompanied by a symbol, e.g. "Flight arrivals" shows the Transport Canada symbol of a landing airplane, "Escalator" shows the escalator symbol. When the symbol or the text are touched, the page changes to the required choice.

If a traveller is hearing impaired, all messages are displayed in visual mode, providing him/her with print-outs whenever necessary. For lesser degrees of hearing impairment a telephone with a volume amplifier was planned, but this item is only available for commercial pay phones. Ideally a TDD would be integrated with the system. At the completion of this phase, this was discussed with the phone company. If a traveller is speech impaired, this person can use visual or audio mode or both. Because a map for the location of facilities can be obtained, the need for embarrassing "questions" along the way is reduced.



Fig.6 Airport map with shortest route

8.6 Installation and demonstration

In May 1990 the Communicaid II prototype was installed at Vancouver International Airport at level 3. This location was chosen because of its central position. The prototype was demonstrated to airport authorities, representatives of the airlines, and the "Green Coats", a group of volunteers who assist elderly and disabled persons, and the general public in the airport. Because the flight information system at this time was not available for integration into the Communicaid system, a temporary arrangement was made with Rogers Cablevision of Vancouver to use the data they display in hotels, etc. Although this data line's data updating and availability of flight data from all lines was limited, it nevertheless showed the potential for displaying flight data in the Communicaid system. After the first couple of weeks the theft of a proximity sensor from the unit interrupted operations.

It was evident from the beginning that the age of the available hardware, e.g. the 286 PC model 1985, and the printer, HP laser, 1985, would limit the system, especially concerning the speed at which the pages would be generated, and the capacity of the printer tray. After several months of demonstrations the unit was removed from the airport for further development. Exposing the passenger to limited flight data information and some deficiencies in the system design is acceptable for a short demonstration but not for longer periods of time. Although COMMUNICAID was clearly marked as a "Prototype", passengers nevertheless expected a perfect working system. To achieve this a pre-production model must be built.

9. CONCLUSIONS

The Communicaid II prototype development has been brought to a successful stage for a number of reasons:

- It defined the interfaces required to address the information requirements of sight, hearing and speech impaired travellers, of those using wheelchairs and of elderly persons in an airport environment.
- It defined the technologies necessary to address visual and audio interactive tasks.
- It defined the technical requirements for interfacing the present airport information system, such as FIDs.
- It showed the operational parameters necessary for an independent system in an airport.
- The principle of Communicaid II was received enthusiastically by the disabled community.
- New ground was cut in the interfacing of impaired passengers with information technology.

The prototype also showed to what degree compromises have to be made between ergonomics, technical, operational and manufacturing requirements.

The ergonomics evaluation indicated several areas for improvements: some due to the software capabilities of the system, e.g. slow screen drawing rate; others to the outdated hardware components, e.g. small paper tray for printer, or to compromises due to operational requirements and conflicting requirements between different disabled groups, e.g. size of seat, location of telephone.

The prototype is presently at the premises of the contractor who is doing additional development and testing work at his own cost to advance development to the pre-production stage.

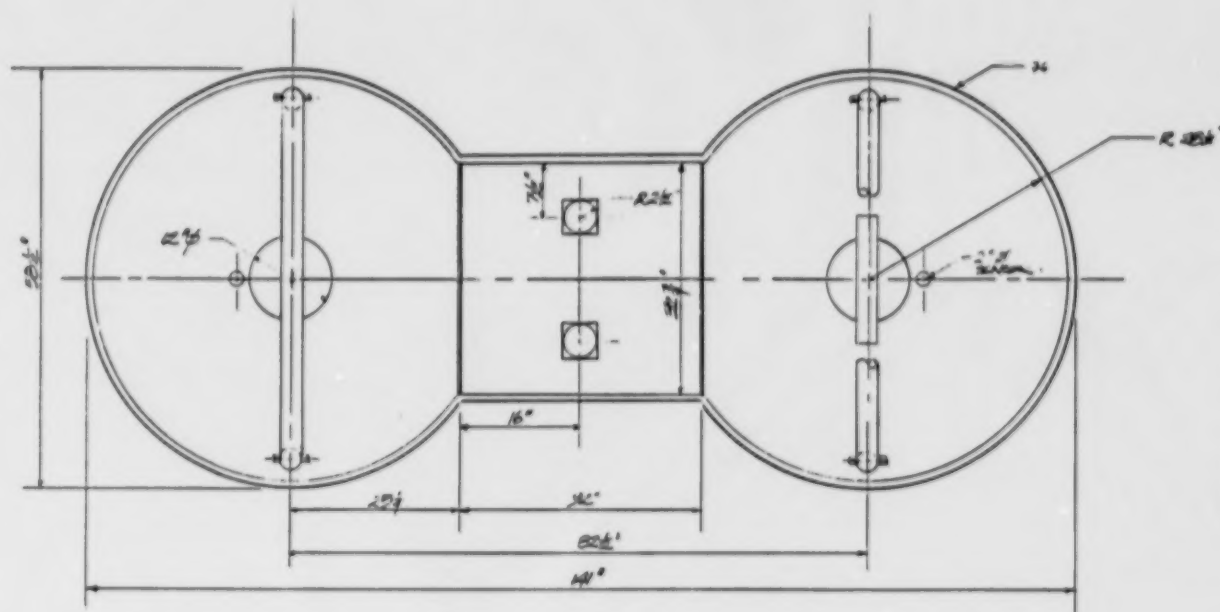
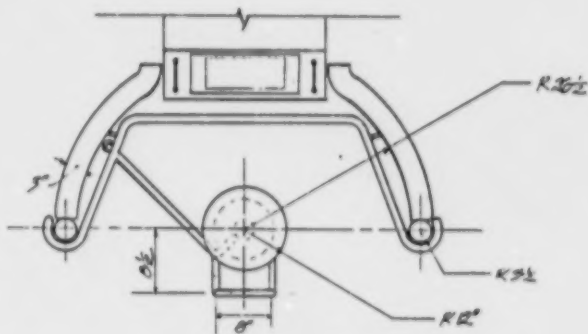
10. RECOMMENDATIONS

The prototype is now ready for the next step, which is the fabrication of a pre-production model with equipment for commercial use, such as interactive video disc technology, track ball control, large storage high speed laser printer and a modular systems design providing a generic system with authoring facilities on-site or by modem. A modular approach to the hardware design addressing the operational requirements of airports with different passenger capacities and present FIDs systems is being considered.

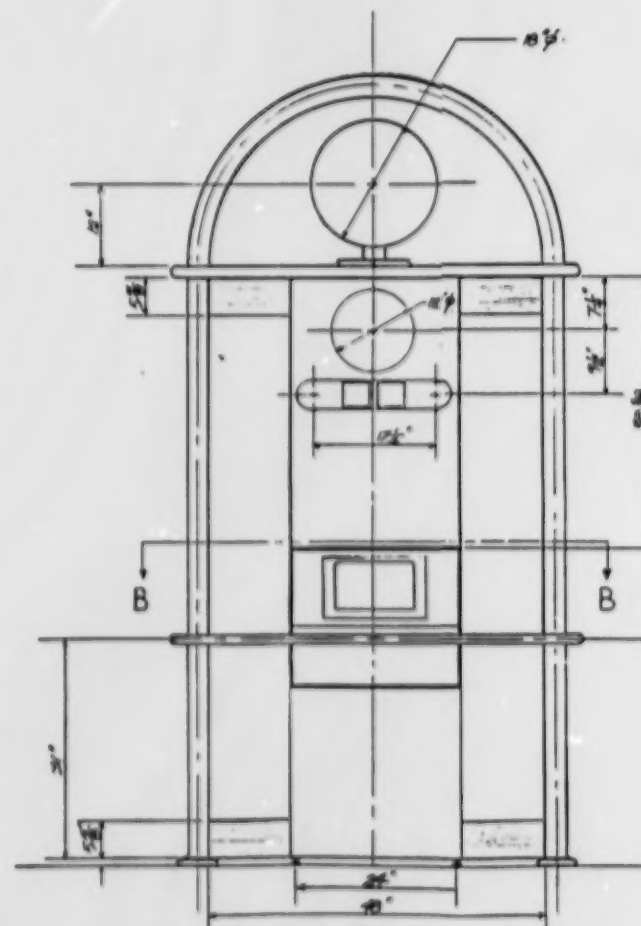
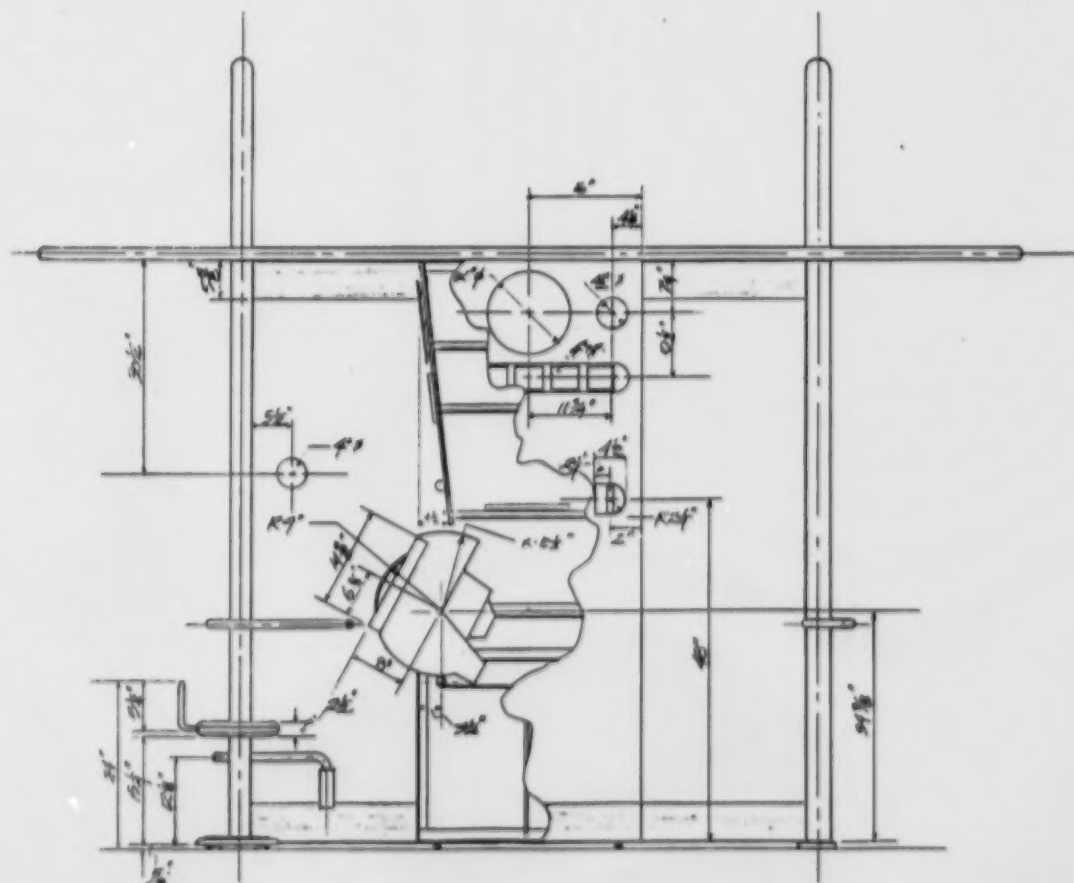
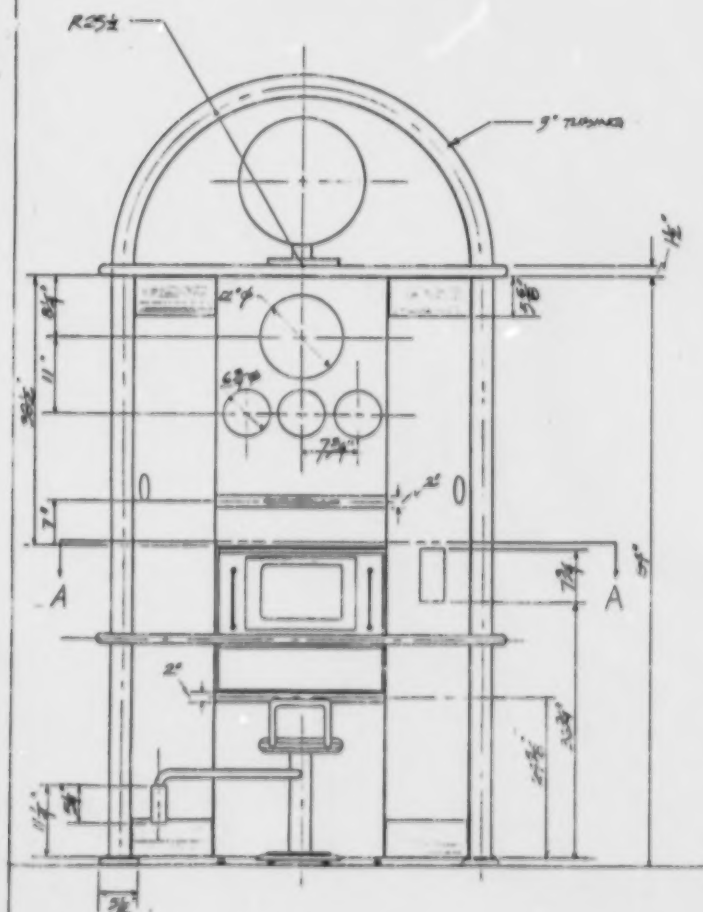
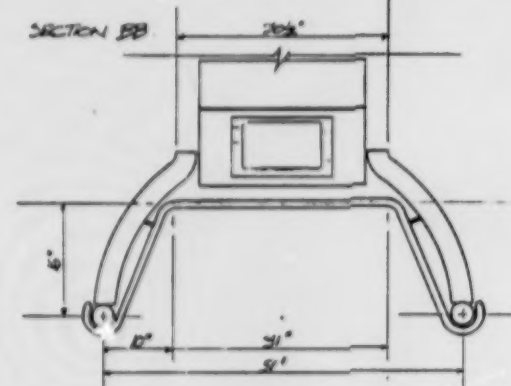
These refinements are required before introducing this product into the marketplace and exposing it to potential applications for national and international markets.

APPENDIX A: Technical drawings

SECTION AA



SECTION BB



ROTHBERG DESIGN INC.

100 - The Avenue, Toronto, Ont., Canada M5S 1A7
Tel. (416) 514-0119

Project/Process - GENERAL DESIGN 2

Title/Title - GENERAL DESIGN

Design/Design/Design - R. P. M.

Draw/Draw - R. P. M.

Check/Check - R. P. M.

APPENDIX B: Ergonomic evaluation

Ergonomic Evaluation of Communicaid II

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Introduction

This report deals with an ergonomic evaluation of a menu-driven information system called Communicaid II which is designed to be used independently by sight, hearing and speech-impaired travellers in a transportation terminal. Travellers can obtain details on flight arrivals and departures; airport facilities; ground transportation (e.i. buses, taxis, car rentals); associations for the disabled and hotel facilities.

The following activities were carried out for the evaluation:

- 1) conferred with the system's designer, U. Rutenberg to obtain details of the system.
- 2) designed an ergonomic evaluation protocol that will be sensitive to sensory, perceptual, cognitive, motor and psychological factors relevant to the use of the system.
- 3) administered the protocol to force the emergency of design deficiencies.
- 4) Prepared a technical report, describing the method, conduct and results of the study, commenting on the suitability of the system and making recommendations regarding any modifications needed to render the system ergonomically sound.

1.0 Description of Communicaid II

The Communicaid II information kiosk was designed by Rutenberg Design Inc. with software and speech synthesis designed by the Center for Speech Technology of the University of Victoria. This system was developed on behalf of the Transportation Development Center of Transport Canada.

The Communicaid II is shown in figure 1 to 4. Its major components are:

- two information booths situated at opposite ends of the system. One of the booth is a stand up only facility and the information can only be received visually. The other booth provides a seat and the information can be received both visually and auditory. Also this booth can accommodate a traveller with a wheelchair.
- one VDT is present in both booths.
- one of the booths has two small wall mounted speakers . This same booth has a slot in the wall for printouts to be picked up by traveller.
- between the two booths is a door which gives access to a laser printer, a power bar, two keyboards and two CPU's.

Figure 1. View of the booth which provides both audio and visual information.



Figure 2. View of the booth which provides information visually only.



Figure 3. View of the side of Communicoid II.



Figure 4. View of the inside of Communicaid II showing the laser printer and cpu.



2.0 Ergonomic Evaluation Protocol

2.1 Subjects

The people that were involved in assisting this evaluation in one form or another were diverse. Information was attained from: a) an on-site Transport Canada employee who is responsible for Communicaid II; b) a representative of the Canadian National Institute for the Blind; c) a representative of the Canadian Paraplegic Association; d) a representative for the Hard of Hearing Association; e) "Green Coats" who are volunteers helping travellers with information queries and f) travellers. It should be noted that all three representatives had had hands on exposure with the system and had performed their own evaluation of the system.

2.2 Apparatus

A camera and video tape were used for recording vital information. A measuring tape was also used for gathering data on measurements of certain system features.

2.3 Procedure

Each association representative was asked questions depicting potential problems with the system as related to each association's clientele. The Transport Canada employee was asked to comment on feedback she had received from travellers and she was also asked to perform a regular maintenance task (e.i. filling up the paper tray of the laser printer). Another Transport Canada employee kindly gave some of her time to simulate a traveller in a wheelchair using the system. The "Green Coats" were asked about any traveller's feedback on system and to give their personal opinion of the system.

Several planned videotape sessions using the system were performed by this consultant. The purpose of these sessions was to try and depict any flaws with the controls and displays of the system. This particular data was later used for carrying out a function analysis.

Finally, long hours were spent observing travellers using the system.

A task analysis was not performed since it would have been to duplicate a previous evaluation done by Heron, 1986.

2.4 Results

2.4.1 Announcement and location of Communicaid II

2.4.1.1 Problems

- The present location of Communicaid II is on the third floor of the Vancouver International Airport near the information booth. This particular floor is where the departures take place. Also, to one side of Communicaid, is the handrail for a staircase nearby (see figure 5). According to the feedback from the "Green Coats", Communicaid is situated on the wrong floor. The third floor is filled with people who are going out and usually do not requires as much information. The "Green Coats" believe that Communicaid should be moved down to the second floor. The second floor is where travellers arrive and they are the people who are most likely to need information on hotels, etc. Also, the "Green Coats" are encouraged by Transport Canada to bring travellers to the booth. However, they do so rarely as they much prefer in handling

any inquiries themselves (they believe that travellers prefer person to person contact).

- The announcement of Communicaid is made by two "INFO" displays which are situated on the top at each end of the booth (see figure 6). There is no prior announcement of the location of Communicaid and the two "INFO" displays are not easily seen when standing far from the system. The reason for this is that the airline counters have overhead displays which are situated in the direct line of site with the "INFO" displays.

Figure 5. View of the location of Communicaid II

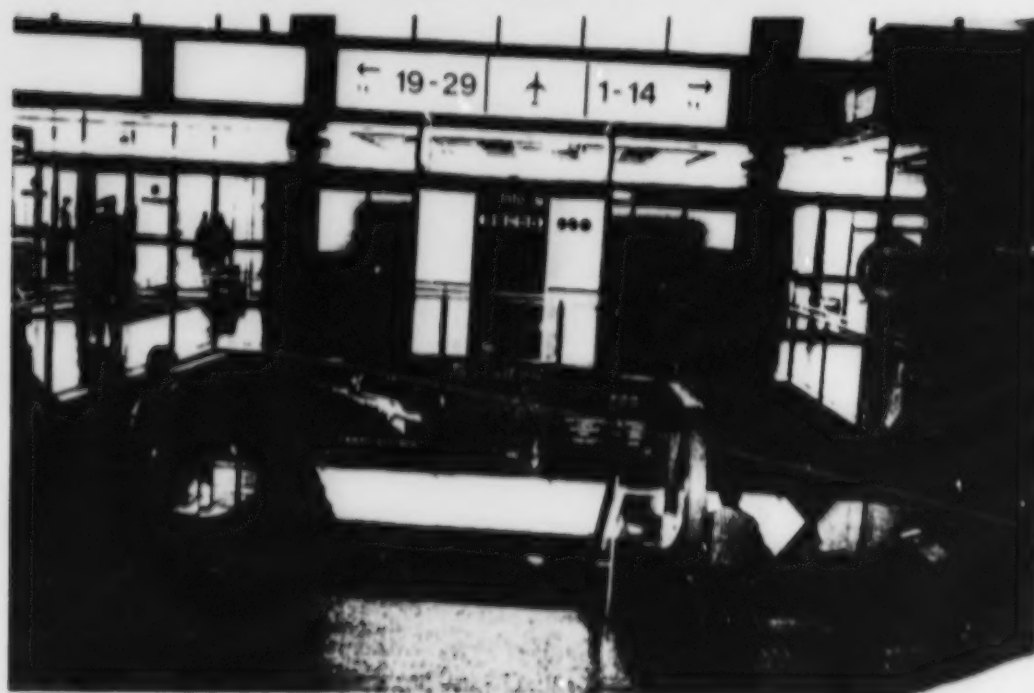


Figure 6. The "Info" signs are located at each end of Communicaid II.



2.4.1.2 Recommendations

- Communicaid should be located on floors identified as needing the most information by traveller.
- Communicaid should not be placed beside any obstacles (i.e. handrails, etc.); since some of the directional instructions given by the system require the person to walk into the handrail located beside it.
- Much more announcement perhaps in the form of signage should be implemented in order to help travellers in locating Communicaid.

2.4.2 Physical Design Characteristics of Communicaid II

2.4.2.1 Problems

- The side doors for access to the laser printer/cpu units are heavy and difficult to remove and install. The handles used for lifting the doors are too high.
- From a servicing point of view, one has to use a lever (i.e. a screwdriver) in order to free the shelf on which the laser printer is placed. Also, the shelf does not come out far enough so as to allow the removal of the paper tray from the laser printer (see figure 7). The laser printer has to be pulled on the shelf in order to clear the paper tray from the system's metal frame (see figure 8). Furthermore, the laser printer is situated too high as a small stature person will not have easy access to the paper tray. Finally, a person in a wheelchair could not complete any servicing due to: a) the height of the laser printer and b) the force needed to pull out the laser printer on the shelf.

Figure 7. The paper tray cannot be removed by simply sliding the shelf out.

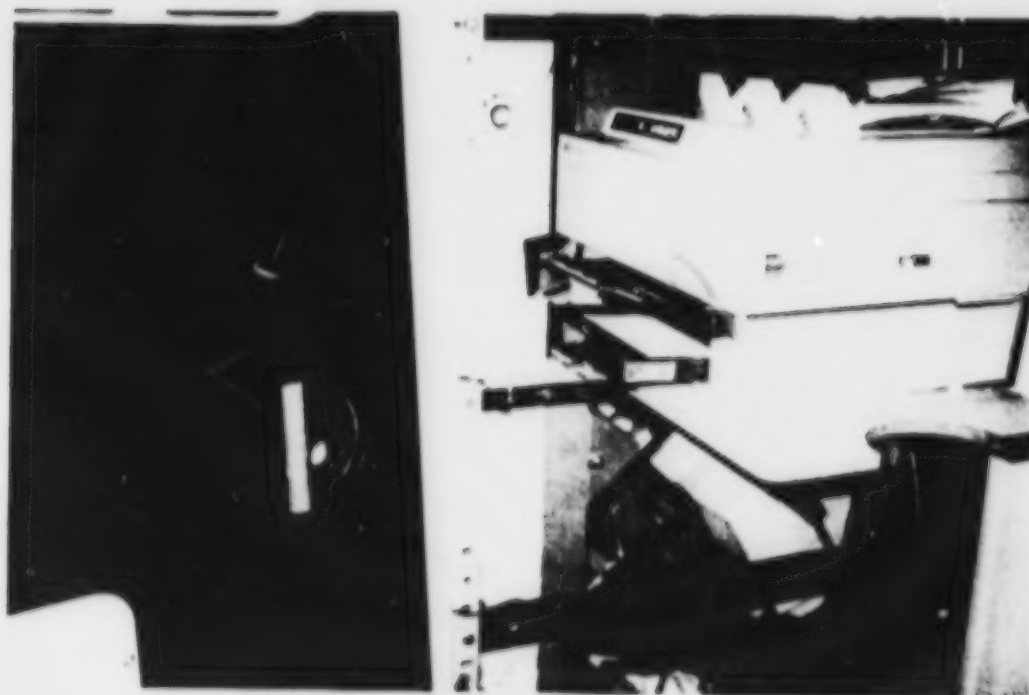
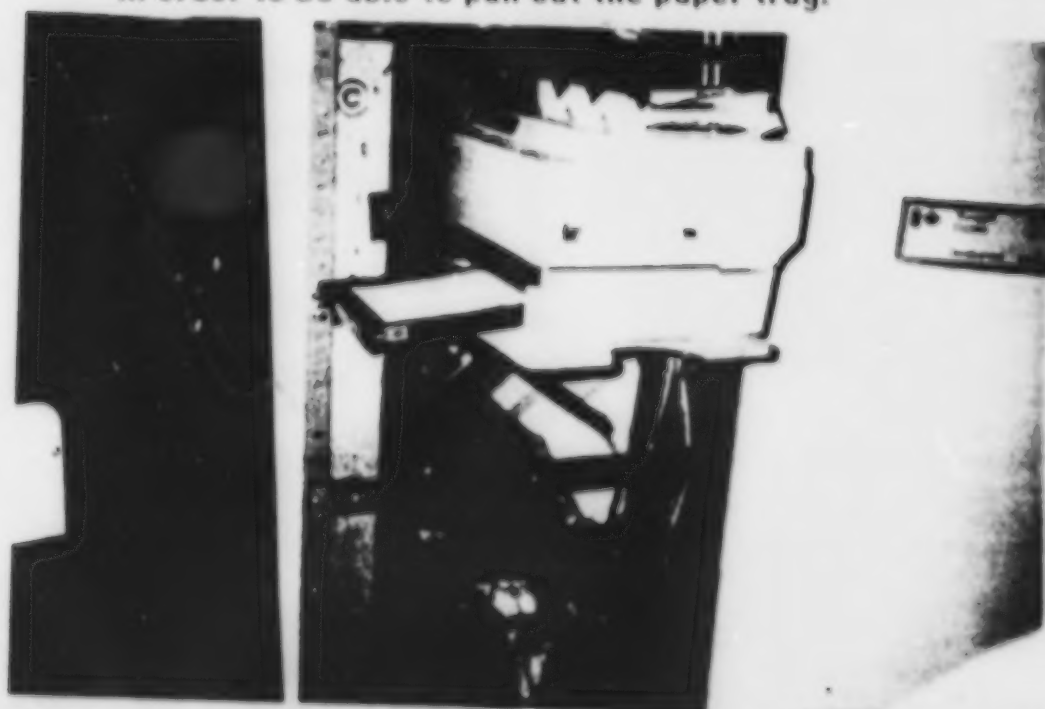


Figure 8. The laser has to be pulled to the edge of the shelf in order to be able to pull out the paper tray.



- If the booth which provides both audio and visual mode is kept busy, a traveller needing such services will have to wait; thus, increasing the likelihood that the traveller will not want to wait and he/she will have to find some other way of getting information.
- Based upon the observations, it became clear that ample space was provided for wheelchair access at one of the booths. Unfortunately, a potential user with a scooter could not get close enough to the screen due to the limited available space for such a transporting device.
- Task illuminance level (amount of light received over a work surface) is quite low (note: no definitive measurement was taken).
- The frame tubing situated on both sides of the entrance to the booth, is made out of steel and it could be painful if someone was to hit themselves on the tubing.
- The motion sensors for triggering the introductory message were not present. According to the Transport Canada employee, the sensors had been stolen.
- The signage on the side of Communicaid is too high. Partially sighted people who have to get real close to target (i.e. sometimes as close as 10cm) may have difficulty because of the height of the signage (i.e. 168.0cm).
- The height of the seat is too low as older people may have difficulties in standing up from such a low seat. The diameter of the seat is too small as it can be quite uncomfortable for some travellers and it does not offer much support for people with poor equilibrium. The color of the seat's texture is almost the same as the floor

covering underneath the seat. This offers poor visual contrast of the seat against the floor background creating problems to people with poor visual acuity in locating the seat.

- The current handle on the seat is extensively used as a lever for assisting people in getting up. It is poorly located since people have to reach behind them to use it and it has broken off from the seat post.
- The minimum distance of the back of the seat to the display is too far. It could create problems for people having poor forward function reach. These people may be required to bend forward unnecessarily.
- The seat is also difficult to be pushed or pulled. This may provide a problem for people in wheelchairs and anybody with poor upperbody strength and with poor grasping strength.
- There is no provision for immediate disposal of printouts near the display; thus people end up leaving the printouts on top of the screen where they can fall inside the booth near electrical outlets.
- The cylindrical shape of each booth offers poor noise refraction. In fact, because of its concave form, external background noises refract off the concave surface and focus at the seating position. This creates an amplification of the noises. Also, the inside surface of the booth is not sound absorbant.
- There is no provision for hand luggage storage. Quite often, travellers had to hold his/her briefcase in his/her hands in order to take out a piece of paper and pencil. They then either used their lap or the wall as a writing

surface. Also, travellers were quite often resentful in leaving their luggage "outside" the booth while querying the system.

- There is provision for tilting the screen which is good idea; however, the force required for tilting the screen would be too high for someone with muscular skeletal problems. Also, the control (a semi circular hard plastic tubing on each side of the screen) for tilting the screen, is poorly designed (see figure 9). Such an orientation of the control (i.e. vertical) is best used for applying horizontal forces and not vertical forces as the ones required to tilt the screen.
- The telephone seems to have caused more headaches than create advantages. The reason being that it is a telephone made by Northern Telecom which is not supported by B. C. Telephone; thus making it very difficult to get parts for the telephone. For example, there is no volume control in the handset for the hard of hearing travellers and it seems to have been very difficult to order a proper handset. Also, the handset does not fit the TDD's supplied by B.C. Telephone.
- There was no provisions of a TDD. This was expressed as a major disappointment by the Hard of Hearing Association's representative. The representative felt that without a TDD, Communicaid II felt short of fulfilling its objective of serving travellers who had hearing impairments.
- The glare on the video display was tremendous (see figure 10). The type of glare found is commonly called disability glare and it occurs when there is an area close to the line of sight which has a much higher luminance than the object of regard. A scattering of light in the eye can

Figure 9. View of the controls on both side of the screen which can be used for tilting the screen up or down.

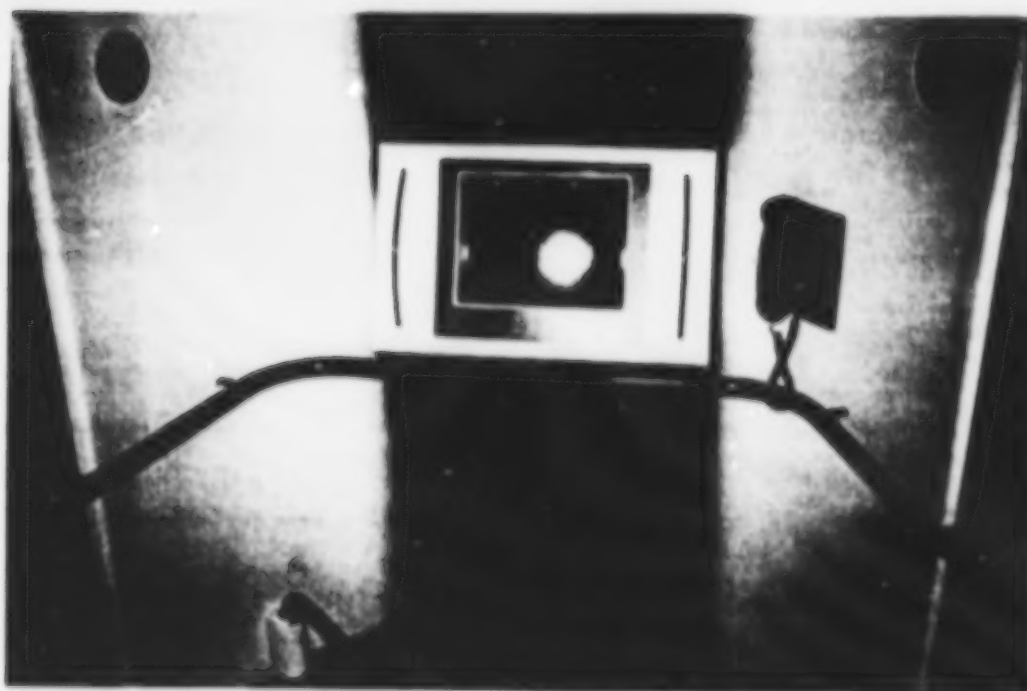
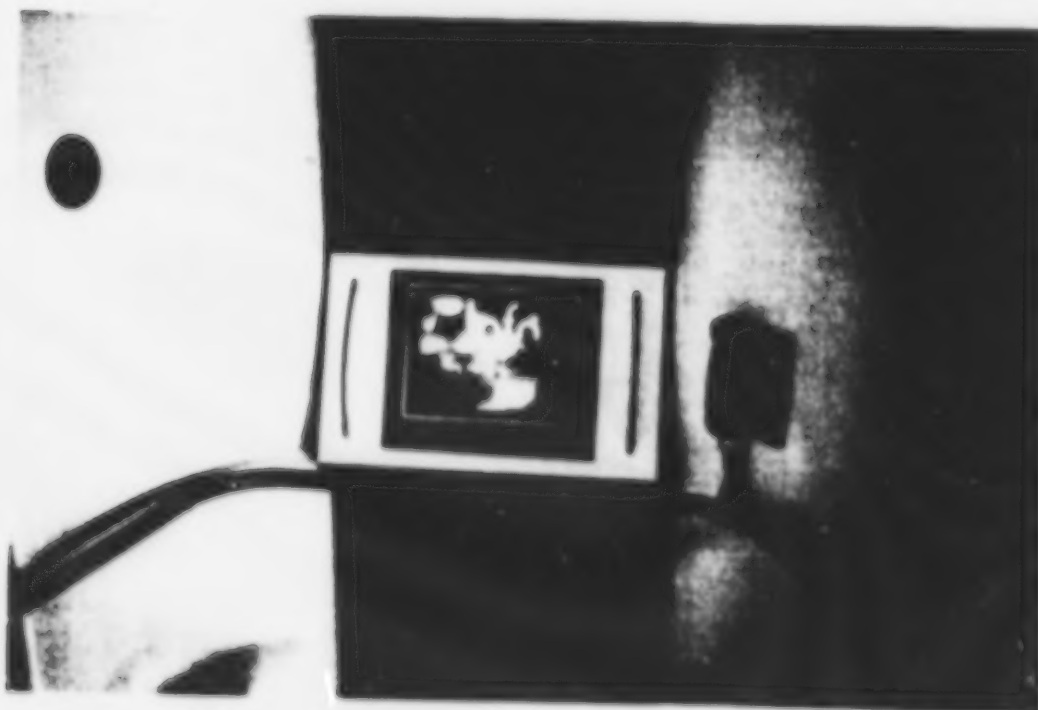


Figure 10. A demonstration of the disability glare which is present.



result causing a reduction in the contrast of the object and even making it invisible. This effect can be amplified for people who have poor visual acuity.

- The printout slot where printout come out is too high because it may be very difficult for some wheelchair travellers to reach for a printout. Also, it does not alert the traveller regarding its location.

2.4.2.2 Recommendations

- The side doors for access to the laser printer should be placed on hinges with the keylock situated at approximately 85cm from the floor.
- The laser printer shelf's sliding mechanism will have to be changed for a much more rigid system. Also, it should allow for the laser to sufficiently come out of the frame so that the paper tray can be unloaded /loaded without having to pull out the laser printer. The laser printer shelf should also be lowered so as to provide better access to the laser printer by small stature and wheelchair bound service people. This particular height would have to be carefully evaluated as this would affect design requirements of the printout slot and possibly the video display.
- Both booths should be designed with identical facilities (i.e. visual and audio modes) to assist in presenting information to all travellers including those with hearing, speech and visual impairments.
- The booths should be redesigned so as to provide sufficient space for travellers with scooters to approach the controls in order to get information from system. The

actual size of the booth would have to be researched with mock ups using scooters and wheelchairs.

- The task illuminance level should be brought up to at least 500Lux (CIBS code 1984). This would best be achieved with local lighting (a light source in the booths) and placed in such a manner so as avoid creating glare on the display screen.
- The frame metal tubing should be covered by some impact absorbing materials.
- The motion sensors will have to be secured in a more theft proof manner. They are a very important feature to the system and without their use, vital information cannot be presented to the travellers.
- The international symbols on the side of Communicaid should be located at two separate locations for use by wheelchair and walking travellers with partial visual impairments. The symbols should be located at 105.0cm and 150.0cm from the floor to the middle of the symbol. These measurements were attained from anthropometric data while sitting and standing.
- The seat height should be brought up to 60cm with a seat width of 36cm. The color of the seat should be black. Elbow rests should replace the current handle in order to more efficiently assist people in standing up. The number of elbow rests (1 or 2) should be researched so as to obtain the best compromise between ease of sitting on seat and assistance for standing up. The elbow rest height should be 15cm high and padded. The minimum distance of the back rest to the display should not exceed 65cm. Finally, the seat should be made more easy to move (i.e. pushing/pulling it).

- There should be provision for immediate disposal of printouts. Perhaps some type of flush wall mounted waste bin would be appropriate.
- The shape of the booth should be changed to a square as opposed to a cylinder. Also, this would have to be considered with the above recommendation for providing sufficient access space for scooters. The inside surface of the booth should be replaced with a more sound absorbant material.
- A writing surface should be included in every booth. This could be used for temporarily storing hand luggage and/or be used as a writing surface.
- The control for tilting the screen should placed horizontally and replaced by a lever mechanism.
- The telephone implemented in the booth should be supported by the provincial telephone company where Communicaid is installed. Volume control in the handset is mandatory.
- A TDD should be provided for assisting the hard of hearing in getting further information.
- A glare filter screen should be installed over the video display so as to reduce or eliminate all the disability glare.
- The printout slot should be located as close as possible to the video display since it will be within easy reach and the slot could alert the traveller when a printout is generated. This could be accomplished by having the slot light up when a printout is present.

2.4.3 System Activation and Instructions

2.4.3.1 Problems

- As mentioned previously, the motion sensors for triggering the introductory message were not present; therefore, when a traveller stepped inside the booth nothing happened. If the traveller was blind, he/she was not given any introductory message to the system.
- Because of lack of instructions on system operation, many travellers sat down and listened to the phone expecting to be able to interact with system via phone.
- There is clearly no instruction (visual) indicating the need for touching the screen in order to activate it. This perhaps explains why people pick up the phone expecting some interaction with the system.
- It was expressed by the Transport Canada employee that for some travellers, there may not be enough time elapsed between the presentation of instructions and the time needed by a traveller to sit down and approach the video display. The main problem is that travellers have to attend to the instructions while trying to locate the seat and get ready for interacting with a system they may know very little about.
- No further comment can be made on the quality of the operational instructions since they were not operative at the time of this evaluation.
- The system will activate itself and present screens which contain some information on for example, location of washrooms and telephones. The problem is created

by travellers who get the impression that the system is non interactive and that it displays preset information.

2.4.3.2 Recommendations

- Perhaps more than one type of sensors should be installed so as to make sure that the instructions are given in audio mode upon entering the booth.
- There should be a message on the video display advising travellers to touch a control in order to activate the system.
- Sufficient time should be given to travellers for "settling into the booth" before any instructions are given. The specific amount of time would have to be carefully researched using mock ups and carrying out user trials.
- There is no need for the system to be presenting these information screens since everyone observed did not seem to care for the information provided and even if they wanted to receive the already presented information, they activated the system and went through its menus regardless.

2.4.4 Visually Displayed Information

2.4.4.1 Function Analysis

In order to assist with identifying potential problems with the software, a function analysis was carried out. The purpose of carrying out a function analysis is to use it as a comparison and evaluation tool for specifications of:

- a) the interface input/output representations.

- b) the sequence of dialogues.
- c) the control structure for interfaces, dialogues and software computation (Williges et al, 1986).

2.4.4.1.1 Method:

A list reflecting the inputs/outputs of the system was formulated using taxonomies of generic function and actions performed through human-computer interfaces (see Cohill, 1984; Lenorovitz, 1984). The terms used to depict the inputs/outputs were selected based upon user requirements. (i.e. information processing requirements and specific information requirements).

2.4.4.1.2 Results

The terms used to depict the inputs/outputs were then incorporated into a flow-diagram to show the order in which each of the functions were to be performed. It should be noted that the results indicate how the system should be performing and not how it is presently performing. The results will be used for comparative and evaluative purposes against the present system. See figures 11 to 14 for flow-diagram.

2.4.4.2 Problems

- There is no tactile information given to the traveller with regards to the location of controls on the screen. Even, with the audio mode activated, it does not indicate the location of the control. This is a major design flaw of Communicaid II; since it renders the system inoperative by a blind traveller. A blind traveller is given no information

Flow Diagrams of the Function Analysis

Figure 11: pp. 27 to 29.

Represents the function of introducing the system to a traveller.

Figure 12: p. 30.

Represents the function of selecting a particular topic.

Figure 13: p. 31.

Represents the function of returning to a previous screen.

Figure 14: p. 32.

Represents the function of printing.

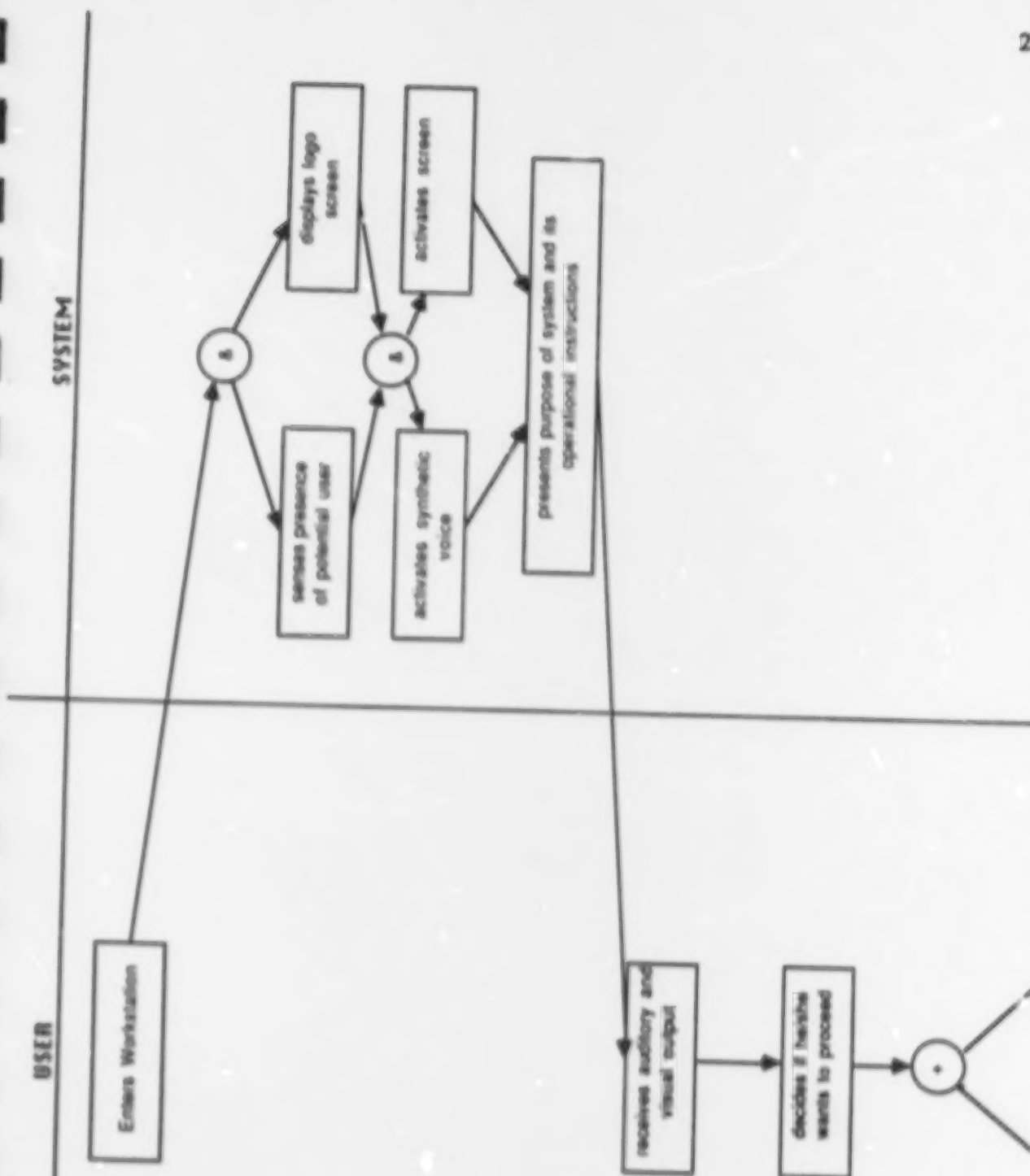


FIGURE 11 - FUNCTION OF INTRODUCING THE SYSTEMS TO TRAVELLER

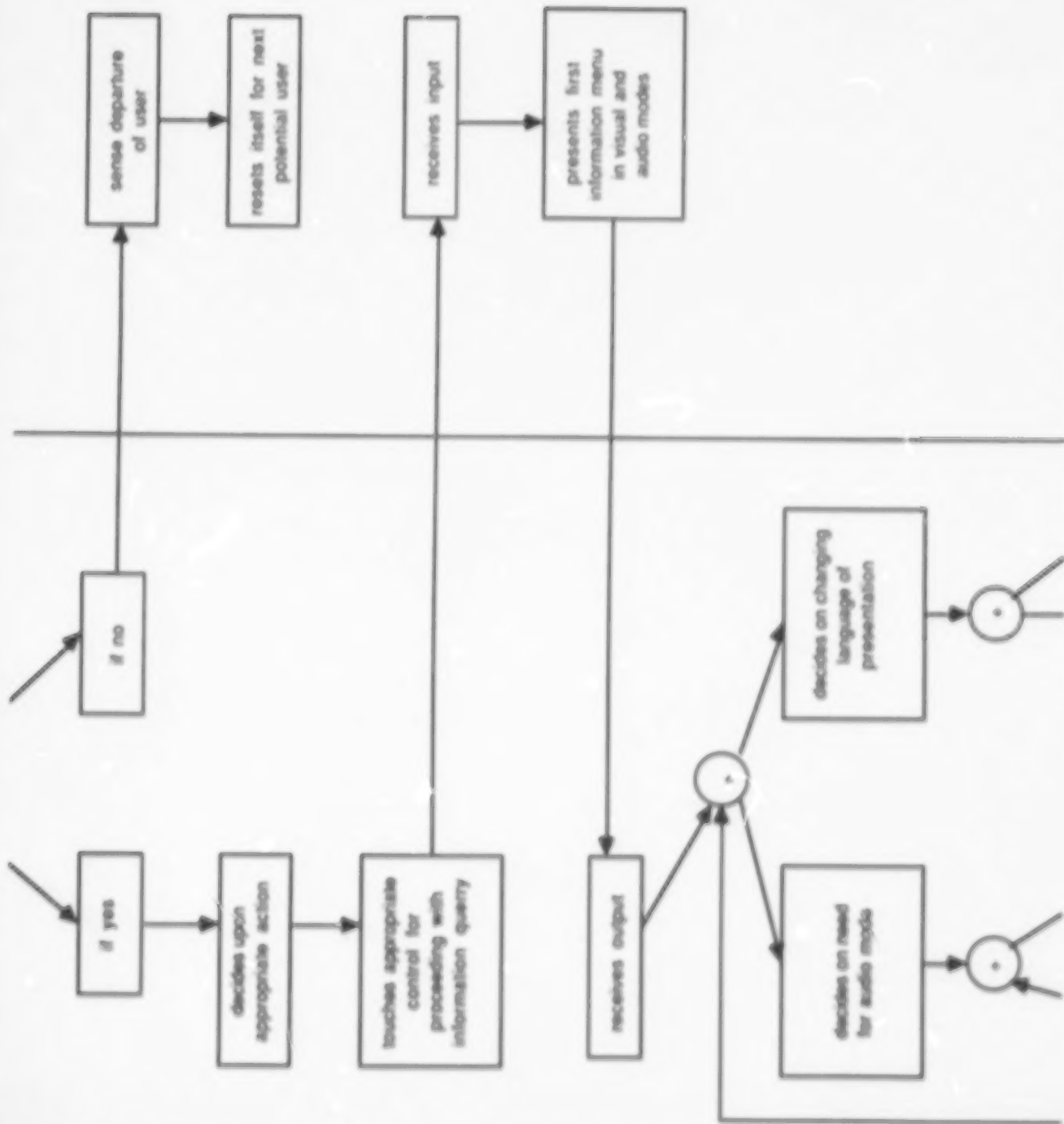


FIGURE 11 - FUNCTION OF INTRODUCING THE SYSTEM TO TRAVELER

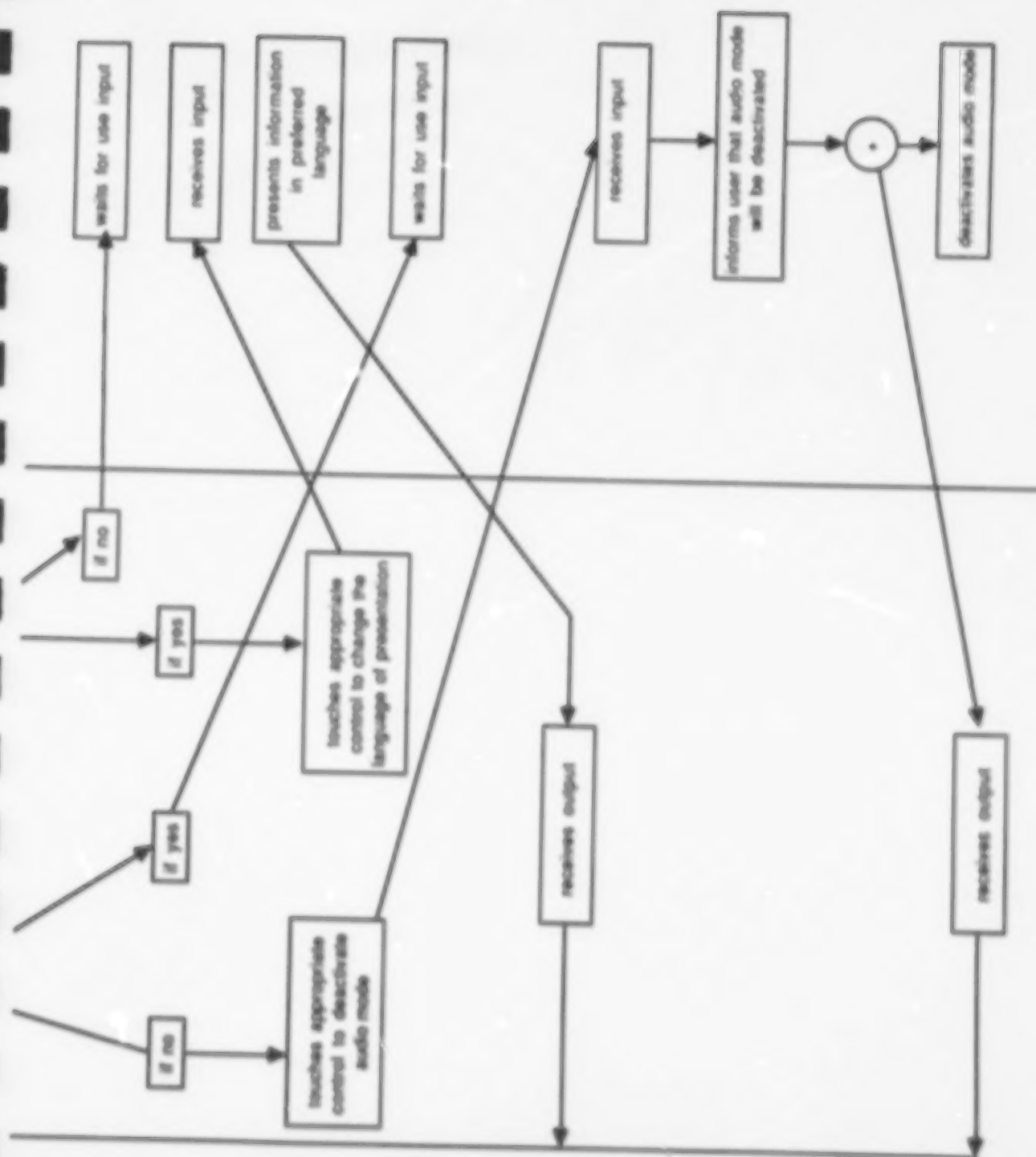


FIGURE 11 (CONT'D) - FUNCTION OF INTRODUCING THE SYSTEM TO TRAVELLER



FIGURE 12 - FUNCTION OF SELECTING A PARTICULAR TOPIC



FIGURE 13 - FUNCTION OF RETURNING TO A PREVIOUS SCREEN



FIGURE 14 - FUNCTION OF PRINTING

of where to touch on the screen in order to get information on a particular topic.

- The use of the color fascia for the floor layouts offers poor contrast with the white line drawings representing wall separation.
- There is a discrepancy between how the information is presented on the screen and how it is printed.
- The speed of execution for displaying the information is excessively slow. This was the number one reason for travellers leaving Communicaid II halfway through a session. They could not wait or got really impatient with the system and proceeded on with their queries to the closeby general information desk.
- Once a touch button was activated, it sometimes went from a blue to a red color . This was a good feature; however, it was not consistent across all levels of the system and the selecting of the color red may provide some problems to color blind travellers.
- Some of the information provided by the system is not accurate such as bus fares, bus numbers and location of wall separation.
- Because of the size of the touch buttons on the screen, difficulties may arise for travellers with poor eye/hand coordination.
- Quadreplics will not be capable of activating the system because of the lack of adequate input devices.
- Not all the airlines are displayed. For example, the affiliated airlines are not displayed on the main menu.

Thus, if a traveller does not know that KLM is affiliated with Air Canada, he/she may have difficulties in getting flight data for KLM.

- Flight departure and arrival data is provided by Rogers Cable which has a slow update. Normally, the data is only given for approximately one hour ahead of time. It sometimes displayed information on "old" departures or arrivals.
- In the case where there is no flight departure or arrival data for a particular company, the system does not display anything. This was very misleading as some travellers did not know if the lack of information was caused by a system failure or that no data was available.
- The software is self paced as opposed to user paced. This creates major problems since quite often the system resets itself without giving enough time for reading the information.
- There is not always the provision for returning to a previous screen. Also, terms such as "menu" and "main menu" are used for indicating to the traveller the possibility of going back to previous screens.
- The message of "Please Wait" once the printing function has been activated is inappropriate. Some travellers wondered what was happening. Also, once it has printed the requested information, the system goes back to the screen previous to the one where "print" was activated.
- On several occasions a wrong screen would appear. If this occurred, most travellers would leave the booth.

- The touch screen is not sensitive enough! Quite often the selected item would not be presented because the system would not have picked up the touch.
- In french mode, different terms are used to indicate further information can be gathered on a particular topic. The terms "suite" and "continue" are used for the same purpose. This can be misleading to some travellers.

2.4.4.3 Recommendations

- I would strongly recommend to discontinue the use of a touch-screen. For selection controls, push buttons on the side of the screen should be used instead. Each button would correspond to a line on the screen and could be encoded with Braille. Also, by the end of three days of observation, the touch screen became so filthy that some travellers hesitated in touching it.
- For the floor layouts given on the screen, a white background with black lines indicating walls should be used. In talking with the CNIB representative, the later alternative was believed to be much more effective.
- There should be a strong effort in reducing the differences between how the information is presented on the screen and how it is printed. This is to reduce the likelihood of confusing travellers, especially for travellers with little experience with computers.
- The speed of execution for displaying the information should be made as fast as hardware and software technologies permit. The traveller should not have to wait for the system but the reverse should be aimed for.

- The push buttons should light up and become depressed once activated by the traveller. This would signal to the traveller his/her choice.
- The people responsible for the system should assure that the information provided is accurate.
- Given the new development in voice activated devices, it may be possible to eventually incorporate this technology in Communicaid II so as to permit quadriplegics or any other traveller with total upper body disfunctions to gain access to information. An alternative may be to provide foot controls!!!
- The menu for the airlines should be re-written so as to incorporate all airlines which make use of the airport.
- It was suggested by the Transport Canada employee that the flight departure and arrival data will soon be handled by the airport's data system. This will be a major improvement on the present system.
- In the case where there is no flight departures or arrivals, a message should be presented to the traveller indicating that, for example; the chosen airline does not have any flights for that day.
- The software has to be made user paced as opposed to machine paced. This would accommodate for individual differences in information processing and give more autonomy to the travellers.
- The terms "main menu" and "menu" should be replaced by "previous screen". This will reduce the likelihood of confusion regarding what "main menu" and "menu" mean. Also, this facility (i.e. go back to previous screen)

should always be provided as soon as a traveller proceeds to a next screen (i.e. down the hierarchy of information items).

- The message "Please Wait" should be replaced by "Printing", indicating the action which the system is performing. Also, once the system has finished printing it should go back to the screen from which the printing function was activated.
- Only one term should be used across the different levels of the system for indicating that further information is available (for both languages).

2.4.5 Audio Displayed Information

2.4.5.1 Problems

- When the audio mode is deactivated, the audio system does not inform the traveller that the audio mode has been turned off. This may create a problem for a blind person since he/she may not know if it was he/she who accidentally deactivated the audio mode or the system has simply stopped providing information in audio mode.
- In audio mode, no cue (i.e. sound) was given when a control was activated. For a blind traveller, he/she would not necessarily know if his/her selection had been activated.
- Too much time elapsed between the screen presentation and the onset of the corresponding voice. One can get the impression that the audio mode is not engaged.
- Quite often the audio messages would not be given

eventhough, the screen indicated that it was activated.

- Also, the audio mode would deactivate itself.
- There is no provision of a volume control for the speakers. The sound level of the messages is too low given the background noises which can be present.
- The quality of the synthetic voice was perceived by some travellers as being poor. They mentioned that a lot of concentration had to be applied in order to fully understand all the messages.
- There is no audio message which corresponded with the presentation of flight departures and arrivals when the audio mode was activated. Thus, a blind person could not receive any flight data.

2.4.5.2 Recommendations

- An audio signal or sentence should be included in an audio message informing the traveller that the audio mode has been turned off.
- An audio signal should correspond with the activation of a control.
- As soon as the screen has been filled (which should be almost instantaneous) the corresponding audio message should be activated.
- Software "bugs" should be eliminated in order to enhance the reliability of the audio message to come on when it is supposed to.

- Provision for volume control of the audio messages should be made. This will enhance the likelihood for the messages to be heard given the excessive background noise.
- Flight data should be provided in audio mode.

2.4.6 System Maintenance and Staff Training

2.4.6.1 Problems

- If any modifications or problems occur with the system, the Transport Canada employee responsible for Communicaid II has to call the Speech Lab at the University of Victoria and ask for assistance. Assistance can be given directly over the phone or someone is sent. The latter alternative sometimes takes a lot of time for a system which should have as little "down time" as possible.
- In house staff of Transport Canada have received no formal training on servicing Communicaid II other than refilling the paper tray of the laser printer. Although operational and user manuals for the LAN and the computer are provided, they mean very little to the people responsible for Communicaid II.

2.4.6.2 Recommendations

- In-house staff should become fully trained on servicing Communicaid II. For example, in-house computer specialist could be trained on the ways to alter the data presented to the screen. In fact, the Transport Canada employee mentioned that in the near future, a major reorganization of the floor layouts will be carried out.

This means that a considerable amount of information will have to be re-entered in the system. It would be advantageous if an in-house staff could carry out the modifications as and when needed.

- It should be noted that the software means for making software modifications were not seen. It would be very interesting to see how it is carried out. This would certainly help in identifying the amount of training required for in-house staff.

2.4.7 General Recommendations

- A revision of the design objectives should be made. Especially as it relates to trying to provide information in both visual and audio modes for all travellers.
- Should any further modifications be made to Communicaid II, user trials with various target groups (i.e blind, hard of hearing, wheelchair bound) should be carried out prior to implementing the system back in the airport.
- Careful consideration should be given to the electrical power demands placed on the powerbar inside Communicaid II. For example, one outlet of the powerbar was accommodating three plugs. This is certainly an electrical hazard.

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